SSVEO IFA List

Date:02/27/2003

STS - 68, OV - 105, Endeavour (7)

Time:04:08:PM

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-01	TPS
EECOM-02	**GMT:**		**SPR** 68RF08	**UA**	**Manager:**
			IPR	**PR** FWD-5-08-1075	
					Engineer:

Title: Missing Tile Along Aft Edge Of Port Overhead Window (ORB)

Summary: INVESTIGATION/DISCUSSION: At approximately 278:04:50 G.m.t. (004:17:34 MET), the crew reported that a portion of tile no. V070-390068-059 was missing along the inboard aft edge of the port side overhead window (W8). On-orbit video was downlinked that showed that the densified layer of the tile remained attached. The densified layer is approximately 0.10-inch thick. A search of downlink video indicated that the tile was missing since at least 275:09:40 G.m.t. (001:22:24 MET). A thermal assessment was performed to determine if thermal violations would occur to the window assembly or structure during on- orbit operations or during entry because of the missing tile material. The assessment indicated no violation would occur for either phase of the mission.

Launch video revealed a white cloud at the right-hand OMS leading edge at approximately T+36 seconds. At 277:20:46 G.m.t. (MET 004:09:30), the crew downlinked video of the right OMS pod that showed two damaged tiles near the center leading edge of the pod. Postflight inspections of the Orbiter were performed at Dryden Flight Research Center (DFRF). Scuff marks were observed at three locations on the payload bay door (PLBD) in a direct line from the observation window tile to the righthand OMS impact area. OMS pod leading edge impact damage was inspected and samples were taken for laboratory analysis. The laboratory analysis of the OMS pod sample revealed evidence of black reaction cured glass (RCG) tile coating used on the window 8 tile. Upon return to KSC, physical evidence of additional black RCG coating was found lodged in the OMS impact area. The OMS pod tile damage is directly attributable to the window 8 tile failure. The window tile was installed during the OV-105 build on December 20, 1989. The tile was made of 9-lb density material. The tile thickness was approximately 0.5 inch and it was installed on 0.160-inch strain isolation pad (SIP). Two areas of damage to the tile’s outboard insert hole were repaired with densification slurry on flows 1 and 2. A ceramic fill was used to repair the insert hole on flow 6. The tiles around the windows are to be upgraded to a higher strength 12 lb material per an attrition modification, due to the damage prone nature of the carrier panel (C/P) tiles. Thirty-seven observation window tiles have been replaced due to outer to inner mold line cracks. Also, twenty-five observation window aft tiles have been replaced because of stretched SIP resulting from high ascent-flight loads. Postflight inspections of the observation window tile SIP remaining in the cavity reveal hard spots in the SIP adjacent to a previous repair that was performed during flow 6 of OV-105. The hard spots were caused by tetraethyl orthosilicate (TEOS) saturation of the SIP. TEOS is used during performance of an ML0601-9026 procedure TPS-311 repair. The TEOS saturation encompassed about a 1.75 inch diameter area with a 1 inch diameter area being excessively hard. A stress analysis was performed to determine if this condition could have led to the tile failure due to the loss of the strain isolation capabilities of the SIP. The analysis confirmed negative margin of safety using certification loads and contaminated SIP. CAUSE(s)/PROBABLE Cause(s): The contaminated and rigid SIP allowed ascent loads to be transmitted from the structure to the tile and this caused the tile to shear at the densified layer. CORRECTIVE_ACTION: The missing tile was replaced with an upgraded 12-lb tile in accordance with the attrition modification, because of the damage-prone nature of the carrier panel tile. Workmanship meetings with engineering, quality, and shop personnel are being held to ensure proper techniques when repairing tiles in this area. Shop procedures are being updated to minimize the potential for contamination to the SIP. Also a Mod-EO was released to change the window 7 and 8 periphery tiles' SIP from 0.160 inch to 0.090 inch thickness which will prevent excessive tile deflection during flight. This change will prevent stretched SIP discrepancies and minimize any potential SIP hardspot contamination effects. RATIONALE FOR FLIGHT: Thermal assessment of this area during entry has determined that structural temperatures are acceptable, if this window tile or similar tile separate at the densified layer. Also, the inspection of the remaining tile portion and adjecentTPS elements showed no thermal degradation following the re-entry of STS-68.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-02	OMS/RCS
PROP-01	**GMT:**		**SPR** 68RF01	**UA**	**Manager:**
			IPR 67V-0005	**PR**	
					Engineer:

Title: Vernier Thruster L5D Oxidizer Temperature Erratic (ORB)

Summary: INVESTIGATION/DISCUSSION: At approximately 278:18:00 G.m.t. (05:06:44 MET), the oxidizer injector temperature (V42T2525C) on vernier reaction control system (RCS) thruster L5D (S/N 102) began to react erratically. At 278:18:02:37 G.m.t. (05:06:46:37 MET), the oxidizer injector indicated temperature rapidly decreased to below the 130 deg F leak detection limit resulting in the automatic deselection of L5D by redundancy management (RM). A review of the data confirmed that the erratic temperature indication was an instrumentation problem and not an actual oxidizer leak. The indicated oxidizer injector temperature remained offset low in the range of 10 to 100 deg F throughout the mission, and the temperature differential between the oxidizer and fuel injector temperatures was, at times, well over 100 deg F. In the vernier thrusters, the oxidizer and fuel injector temperature transducers are in close proximity to each other and would track each other closely for a leak large enough to cause the indicated oxidizer injector temperature response.

The loss of vernier thruster L5D resulted in the loss of attitude control using the vernier thrusters, which had a significant impact on payload operations. To recover from this condition, a general purpose computer (GPC) memory (GMEM) write procedure was developed to change the oxidizer injector temperature leak detection limit of all vernier thrusters from 130 deg F to off-scale-low. Note that since the GMEM could not be applied to individual thrusters, all vernier thrusters had their oxidizer injector temperature leak detection limits reset. The successful implementation of this GMEM allowed for the reselection of L5D and a return to the vernier thrusters for attitude control. This recovery option allowed operation of the vernier thrusters with RM fail leak detection using the fuel injector temperatures. While the loss of the oxidizer injector temperatures for leak detection resulted in some degradation of the leak detection capability, the fuel injector temperatures provided adequate insight into oxidizer leaks. Thruster L5D performed nominally for the remainder of the mission. Following landing of OV-105 at the Dryden Flight Research Center (DFRC), the oxidizer injector temperature remained offset low. However, upon arrival of the vehicle at KSC, the oxidizer injector temperature for L5D was indicating properly and it has continued to do so since that time. Extensive troubleshooting was performed postflight at KSC. This troubleshooting included a wiggle test and visual inspection of the thruster connector, and tests of the temperature transducer and dedicated signal conditioner (DSC). A final test used a heat gun to apply energy to the thruster injector through the thruster nozzle to simulate flight conditions. Throughout the test, both the oxidizer and fuel injector temperatures tracked closely and were stable with no fluctuations or anomalies. Troubleshooting at the DSC, the Orbiter/OMS pod interface, or the multiplexer/demultiplexer (MDM) was not performed due to access limitations. Vernier thruster L5D (S/N 102) was installed on OMS pod LP04 prior to STS-68. During that flow, no other components in the L5D oxidizer temperature transducer electrical circuit were disturbed (OMS pod removal was not required). CAUSE(s)/PROBABLE Cause(s): The most probable cause of the erratic/offset low oxidizer injector temperature is an intermittent resistance variation in either the temperature transducer or in the wiring from the temperature transducer to the dedicated signal conditioner to the multiplexer/demultiplexer. CORRECTIVE_ACTION: Extensive troubleshooting was unable to repeat the problem. However, vernier thruster L5D (S/N 102) was removed and replaced to eliminate a potential source of the problem. RATIONALE FOR FLIGHT: Vernier thruster L5D was removed and replaced, eliminating a potential source of the problem. Should the problem recur, the vernier thruster oxidizer injector temperature leak detection limit could again be changed, via GMEM, to off-scale-low. As was the case during STS-68, this would still provide for operation of the vernier thrusters with fail-off, fail-on, and, with the fuel injector temperature, fail-leak detection using RM. While the loss of the oxidizer injector temperature for leak detection results in some degradation of the leak detect capability, the fuel injector temperature provides adequate insight into oxidizer leaks.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-68-V-03	OMS/RCS
PROP-02	GMT:		SPR 68RF02	UA	Manager:
			IPR	PR LP04-15-0573	
					Engineer:

Title: Primary Thruster L3D Failed Off (ORB)

Summary: INVESTIGATION/DISCUSSION: Reaction control subsystem (RCS) primary thruster L3D (s/n 325) was declared failed-off due to low chamber pressure (Pc) and deselected by redundancy management (RM) at 278:09:05:45 G.m.t. (05:17:44:45 MET). RM declares a thruster failed-off after receiving three consecutive indications of Pc less than 36 psia. Thruster L3D experienced three consecutive 80-msec firings where the indicated Pc was 10.4, 5.6, and 5.6 psia. The nominal Pc for a primary thruster is approximately 152 psia. There was no indication of a leak, and the thruster remained deselected for the remainder of the mission.

The primary RCS thruster oxidizer and fuel valves have a solenoid-activated pilot poppet and a pressure-operated main-stage poppet. The most common fail- off failure-mode for an RCS thruster is the inability of the oxidizer valve to fully open due to metallic-nitrate contamination in the valve, resulting in the failure of the upper valve cavity to bleed off in time to provide the differential pressure necessary to operate the valve's main stage. Most of the flight data supported this failure mode. Thruster injector temperature data indicated at least partial propellant flow through both valves and did not show the soakback heating associated with a nominal firing. Vehicle rate data also indicated that L3D did not fire nominally. However, fail-offs attributed to metallic-nitrate contamination typically occur on the first use during a mission, and therefore the L3D thruster failure was unique in that it occurred after having been fired nearly 400 times. All L3D firings prior to the low Pc pulses were nominal. Based on this unique aspect of the failure signature, a fail-off failure mode not previously seen during flight, could not be ruled out. Normally, thrusters suspected of fail-off from metallic-nitrate contamination are sent to the White Sands Test Facility (WSTF) for water flushing of the oxidizer valve. If hardware replacement is unnecessary, the thruster is returned to spares at KSC. However, as a result of the unique aspect of this failure, thruster L3D underwent special testing at the WSTF. This testing included a pre-hotfire inspection and checkout prior to a thruster hotfire with full instrumentation. When the hotfire test was performed, the thruster failed-off as a result of the fuel valve failing to open. Oxidizer valve operation during the hotfire was within specification. The initial failure analysis of the fuel valve included a force/deflection test and a teardown evaluation. The force/deflection test produced nominal results. However, during the teardown evaluation it was noted that the Teflon seal in the stainless steel pilot poppet seat was raised out of the seat (extruded) by approximately 0.010 inch. Since the total travel of the pilot poppet is only 0.018 inch (actual travel will vary some due to tolerance buildup), analysis indicates that the restriction created by the extruded seal caused the failure of the upper valve cavity to bleed off in time to provide the differential pressure necessary to operate the valve's main stage. As failure analysis activities were ongoing on the thruster s/n 325 fuel valve, three other fuel valves on the s/n 476, 331 and 432 thrusters exhibited a slow response or failure-to-open using GN2 during flushing procedures at the WSTF (performance was in specification using water). Each of these valves were later found to have extruded Teflon seals. Also, a fourth fuel valve (thruster s/n 497), which had exhibited a nominal response, was cut apart for use as a control specimen and it too had significant Teflon extrusion. Each of these thrusters had been removed from a vehicle for routine maintenance. Extensive failure analysis of the thruster s/n 325 fuel valve seal and seat assembly, as well as the fuel valves in four of the thrusters mentioned in the previous paragraph, has been performed. Varying degrees of extrusion were seen with the thruster s/n 325 extrusion being the most severe. No manufacturing or material anomalies were identified. However, a scanning electron microscope evaluation of the extruded seals suggests an incremental growth pattern and heat was identified as the most probable cause of that growth. As a result, a computer simulation of the stress and thermal cycles that the pilot stage experiences during normal operation was developed. The results of this analysis supports the theory that thermal cycles seen as a part of normal operation can cause seal extrusion. It should be noted that thruster s/n 325 was the fleet leader in terms of equivalent missions on a fuel valve (15 previous flights with 6,470 pulses). Thruster s/n 325 will be reassembled with a new fuel valve and will undergo an acceptance test procedure (ATP) at the WSTF. Upon successful completion of these activities, it will be returned to spares at KSC. CAUSE(s)/PROBABLE Cause(s): The cause of the failure was Teflon-seal extrusion in the fuel-valve pilot-poppet seat. This extrusion created a flow restriction through the pilot poppet, resulting in the failure of the upper valve cavity to bleed off and provide the main stage with the differential pressure required to open. The Teflon seal extrusion appears to be caused by normal thruster operation and/or processing. CORRECTIVE_ACTION: KSC removed and replaced thruster L3D and transferred it to the WSTF for troubleshooting. This troubleshooting included an inspection and checkout prior to a hotfire, which was performed with full instrumentation. Although a contaminated oxidizer valve was suspected to be the most probable cause of the fail-off, the fuel valve failed-to-open during the hotfire test. Oxidizer valve operation was acceptable. Failure analysis of the fuel valve identified extrusion of the pilot-poppet seat Teflon seal as the cause of the fail-off. The extrusion appears to be caused by normal thruster operation and/or processing. Thruster s/n 325 will be reassembled with a new fuel valve and will undergo an ATP at the WSTF. Final results of the thruster troubleshooting and failure analysis will be documented in CAR 68RF02. RATIONALE FOR FLIGHT: The failure mode for a similar occurrence would be a fail-off, as experienced on STS-68, or a fail leak. RM will deselect the failed thruster and in the worst case, manifold isolation could be required in the event of a fail leak. In either event, primary RCS thrusters have multiple redundancy for all nominal mission phases. The failure mode is not a safety-of-flight issue.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-68-V-04	DPS - GPC
DPS-01	GMT:		SPR 68RF09	UA	Manager:
			IPR 67V-0008	PR INS-0179	x30663
					Engineer:

Title: MTU Accumulator 3 Element Bypass (ORB)

Summary: INVESTIGATION/DISCUSSION: During STS-68 on-orbit operations at 279:13:05 G.m.t. (06:01:49 MET), an input/output (I/O) error message,

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-68-V-05	Active Thermal
EECOM-03	GMT:		SPR 68RF10	UA	Manager:
			IPR	PR ECL-5-8-0398	x39045
					Engineer:

Title: FES Accumulator/Hi-Load Feedline A Heater 2 Erratic ()

Summary: INVESTIGATION/DISCUSSION: After reconfiguration of the flash evaporator system (FES) feedline heaters to heater system 2 at 278:15:15 G.m.t. (05:03:59 MET), the FES feedline A high-load line temperature (V63T1895A) went off-scale high (>250?F) for nearly eight hours. The FES feedline A accumulator line temperature (V63T1892A) experienced erratic cycling during the off-scale high period and indicated temperatures above the nominal thermostat control band. The high-load line heater and accumulator line heater are parallel strings controlled by one thermostat. This same signature of erratic accumulator line temperature during periods of off-scale high high-load line temperature repeated several times, although with shorter durations of 1 to 2 hours. A review of prior flight data revealed that this same signature also occurred during STS-59 for short 1 to 2 hour periods. The crew switched back to heater system 1 at 280:04:14 G.m.t. (06:16:58 MET) and the system returned to a nominal temperature signature. FES function was not affected by the condition.

This thermostat design uses a bimetallic disc to make and break the contacts that provide power to the heater. A review of previous failure history revealed a thermostat which failed off during STS-6, a thermostat which failed on during STS-49, and a thermostat which failed off during STS-59. CAUSE(s)/PROBABLE Cause(s): Post flight troubleshooting reproduced the condition and determined that the thermostat controlling FES feedline heater system 2 had failed. The most probable cause for the failure is contamination within the thermostat. CORRECTIVE_ACTION: The failed thermostat was replaced without removal of the FES from the Orbiter. CAR 68RF10 has been opened against this anomaly, however, the Problem Resolution Team (PRT) has decided against performing failure analysis on the thermostat.

RATIONALE FOR FLIGHT: The failed thermostat has been replaced. Should a FES feedline thermostat fail either on or off during a future flight, the system can be reconfigured to the redundant string. Should both thermostats fail on, system temperature control can be maintained by powering the heaters on and off manually to prevent freezing or boiling of water in the line. In the event that both thermostats fail off, freezing of the feedline could occur, however, the redundant water feedline is available with its own set of heaters and thermostats.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-06	Hydraulics
MMACS-02	**GMT:**		**SPR** 68RF03	**UA**	**Manager:**
			IPR	**PR** HYD-5-08-0186	
					Engineer:

Title: WSB System 2 GN2 Regulator Leak (ORB)

Summary: INVESTIGATION/DISCUSSION: The water spray boiler (WSB) system 2 gaseous nitrogen (GN2) regulator (S/N 021) exhibited out-of-specification internal leakage during the STS-68 mission. This leakage was first noted during prelaunch operations when the WSB 2 GN2 tank isolation valve was opened to checkout WSB 2 prior to External Tank (ET) propellant loading. During this first period when the isolation valve was open, a leak rate of about 42 sccm was noted (the OMRSD specification limit is 10 sccm). In accordance with the normal prelaunch procedures, the isolation valve was closed during ET propellant loading to protect against the known problem with regulator internal leakage. The isolation valve was subsequently opened prior to launch and a leak rate of approximately 73 sccm was noted over a 28-minute period. Following the post-ascent WSB deactivation and isolation valve closure, a slight increase in the WSB 2 regulator outlet pressure was seen which indicates some amount of regulator leakage was continuing. The WSB isolation valves remained closed on-orbit to isolate the WSB GN2 regulators from the GN2 tanks. When the WSB 2 isolation valve was opened for entry, a maximum internal leakage of approximately 22 sccm was noted.

As previously mentioned, the WSB GN2 regulators have a history of internal leakage failures. Failure analysis of five regulators that had failed leak tests showed that extrusion of the regulator's balance stem O-ring seal had caused the leakage. Additionally, a failure analysis currently being conducted of a WSB GN2 regulator from OV-103 (STS-60) has found a foreign substance in the balance stem area that is most probably the cause of the internal leakage seen in that regulator (reference CAR 60RF06). Also, transient contamination cannot yet be ruled out as a possible cause of the internal leakage. However, a design modification was implemented in 1992 with the intent of eliminating the O-ring extrusion problem experienced on the -1 through -5 configuration regulators. The balance stem O-ring extrusion was caused primarily by the greater-than- recommended extrusion gap between the O-ring's backup ring and its bore. This allowed O-ring extrusion when the regulator was exposed to pressure and subsequently lead to O-ring

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Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-07	Hydraulics
MMACS-03	**GMT:**		**SPR** 68RF04	**UA**	**Manager:**
			IPR	**PR** HYD-5-08-0185	x39033
					Engineer:

Title: WSB System 1 GN2 Regulator Pressure Decay (ORB)

Summary: INVESTIGATION/DISCUSSION: The water spray boiler (WSB) 1 GN2 regulator pressure began to decay following WSB deactivation post ascent. The slow decay in pressure continued throughout the mission and by entry day, the pressure had decayed to 16.8 psia. The pressure decay was due to GN2 leakage through the regulator relief valve. KSC removed and replaced the regulator. The system was tested satisfactorily.

This relief valve leakage has been caused in the past by a compression set of the valve's knife edge seal as reported under CAR 29RF10-010. Minor relief valve leakage would have no mission effect, since the associated GN2 shutoff valve is closed on-orbit which prevents loss of GN2 from the tank. The shutoff valve is re-opened to pressurize the water tank in preparation for de-orbit when required. The quantity of GN2 consumables available is great enough so that if a low magnitude relief valve leak was to occur, such has been seen during previous missions, there is no risk of losing GN2 pressurization to the associated water tank. However, gross relief valve leakage may result in loss of one APU/Hydraulic system. GN2 leakage on orbit also affects WSB water quantity gauging. The quantity gauging will appear as a slow external water leak. However, water quantity can be verified prior to entry when the WSB GN2 isolation valves are opened for entry. CAUSE(s)/PROBABLE Cause(s): The regulator relief valve allowed leakage of GN2 and this resulted in the decay. CORRECTIVE_ACTION: The GN2 regulator was removed and replaced. The failure analysis of the regulator will be documented in CAR 68RF04. RATIONALE FOR FLIGHT: The GN2 regulator was removed and replaced. If a worst case failure were to occur, the vehicle is certified to return from orbit with two of three WSB's. Furthermore, normal prelaunch and flight operations, the WSB isolation valves are closed when the WSBs are not required, resulting in minimal risk from regulator leakage. For a reentry with a leaking regulator, the APU can be started at terminal area energy management (TAEM) point to reduce the period that the regulator may leak. Impact to a nominal or aborted flight is possible only with gross leakage during ascent or entry when the regulator is not isolated from the GN2 tank.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-08	OI - Recorders
INCO-05	**GMT:**		**SPR** None	**UA**	**Manager:**
			IPR 67V-0015	**PR**	
					Engineer:

Title: Degraded Tracks on Payload Recorder (ORB)

Summary: INVESTIGATION/DISCUSSION: During STS-68 on-orbit operations while performing playbacks of Applied Physics Laboratory (APL) data previously recorded on the payload recorder, degraded data quality was noted on portions of several recorder tracks. The affected areas were the 68- to 100-percent portion of track 2, the 29- to 68-percent portion of track 3, and 84- to 100-percent portion of track 4. The APL data were being downlinked on Ku-Band channel 2. Space Radar Laboratory (SRL) high-rate data were being downlinked on Ku-Band channel 3 during portions of the degraded-data periods. Troubleshooting during the flight using both the forward and reverse directions and the 1 to 16 and 16 to 1 dump ratios did not clear the problem, and tracks 2, 3, and 4 were not used for the remainder of the mission. Track 1 and tracks 5 through 14 were not affected.

Postflight testing verified the data dropouts on the tape in the noted areas. However, when new data were recorded and played back on the suspect tape areas, no dropouts were found. In addition, when the input signal to the recorder was intentionally removed, the data signature was similar to that seen on the degraded tracks during flight. This supports a conclusion that an intermittent connection between the payload and the recorder may be the cause. No further problems were found in the recorder, and the payload has been removed, preventing further testing on the connections in question. All payloads undergo cable connection verification after installment. CAUSE(s)/PROBABLE Cause(s): The most likely cause of the degraded data is an intermittent connection external to the recorder. CORRECTIVE_ACTION: The recorder was tested and exhibited no failure indications. Since the source of the anomalous performance is believed to be with a payload connection, the recorder remains on the vehicle and is considered acceptable for flight. RATIONALE FOR FLIGHT: The degraded data are attributed to a connection problem and the payload that was involved has been removed. Checkout of payloads includes cable connection verification after installment.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-09	C&T - Ku-band
INCO-06	**GMT:**		**SPR** 68RF05	**UA**	**Manager:**
			IPR 67V-0019	**PR**	x31719
					Engineer:

Title: Ku-band Range Rate/Azimuth Display Tens Digit Failed (ORB)

Summary: INVESTIGATION/DISCUSSION: At approximately 283:16:30 G.m.t, (010:05:54 MET), the crew reported that the tens digit of the Ku-Band range rate/azimuth digital display on panel A2 was malfunctioning. Only the upper left segment of the tens digit was illuminated. A lamp test was performed and all of the digits illuminated correctly. The fault light on the range/elevation and range rate/azimuth digital display unit was illuminated at all times even during the lamp test. For Ku-Band stow, the crew used OPS 201 since the elevation readout on panel A2 was not available. Troubleshooting at KSC repeated the problem (one additional digit failed). This is the second occurrence of this specific failure experienced with this particular rendezvous radar indicator and the fourth rendezvous radar indicator failure experienced on OV-105. Further troubleshooting at KSC found the inputs on the digital display unit to be nominal isolating the failure to the digital display unit.

CAUSE(s)/PROBABLE Cause(s): The most probable cause is a component failure within the range/elevation and range rate/azimuth digital display unit. CORRECTIVE_ACTION: The range/elevation and range rate/azimuth digital display unit was removed and sent to the NASA Shuttle Logistics Depot for test, teardown, and evaluation. A spare unit is available. Final corrective action will be documented on CAR 68RF05. RATIONALE FOR FLIGHT: CRT displays exist that provide the information lost for this mode of failure during flight. This mode of failure does not endanger the crew or the vehicle.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-68-V-10	Hydraulics
MMACS-11	GMT:		SPR 68RF06	UA	Manager:
			IPR	PR HYD-5-08-0187	
					Engineer:

Title: WSB System 3 Leak (ORB)

Summary: INVESTIGATION/DISCUSSION: The water spray boiler (WSB) 3 GN2 regulator pressure exhibited a rapid decay immediately following auxiliary power unit (APU) shutdown. This pressure decrease was an indication of a GN2 and/or a water leak in the WSB. The pressure dropped from approximately 38.1 psia to 19.8 psia in just over 1 hour. Review of the data determined the leak began at approximately weight on wheels (WOW). Water was observed coming from the external tank (ET) umbilical doors and the centerline hinge shortly after wheel stop. It was later verified that approximately all the WSB water tank quantity (100 lb) leaked into the aft compartment. Water loss following APU deactivation indicated that the leak source must have been between the water tank and the spray valves.

Once access to the aft compartment was obtained at Edwards Air Force Base, the source of the water leak was determined to be a cracked APU lube oil water spray valve (s/n 035) in WSB system 3. The failure analysis was started when OV-105 was returned to KSC. A team comprised ofJSC, KSC, Rockwell-Downey personnel was formed to identify the cause of the leak and the corrective action. The valve was removed from the vehicle and sent to MAB laboratory at KSC where failure analysis was initiated. Failure analysis identified an intergranular crack in the E-Brite portion of the spray-valve inlet tube. The intergranular crack was 360? around the circumference of the inlet tube with no evidence of weld involvement. There was visible evidence of corrosion products on the entire fracture surface with the color of the E-Brite surface indicating the presence of iron and other metal oxides. The failure analysis confirmed embrittlement and a corrosion-susceptible microstructure with evidence of large grains and carbon content. Metallography of the inlet tube revealed that the intergranular corrosion had propagated from the inside diameter (ID) surface. The hydraulic water spray valve (s/n 036) located on WSB 3 was examined to evaluate the unique nature of spray valve s/n 035's failure. The s/n 036 valve was constructed at the same time as s/n 035 and with the same raw materials and processes. Both valves had seen an identical operational environment. Extensive analyses were performed to charaterize any corrosion in s/n 036. Metallography of this valve revealed no internal cracks or evidence of corrosion. The external surface of the s/n 036 valve was optically examined with 50-power magnification and no external cracks were observed. Inspection by X-ray and eddy current provided no evidence of intergranular cracking and lastly s/n 036 was sectioned and found free of intergranular corrosion. Eight other flight APU lube oil spray valves were examined including the fleet leader valves and no evidence of intergranular cracking was found. Due to the findings of these eight valves and s/n 036, the failure of s/n 035 is believed to be unique. The exact cause of the intergranular cracking of the E-Brite material is still under investigation with testing continuing. Additional fractography and metallography will be performed to charaterize the oxides in an effort, to identify the corrosive agent, and to reproduce the fracture. A torque test was developed to assure no similar extensive cracks exist in the remaining inventory of valves in the fleet. The torque (150 in-lb) applied at the WSB valve-inlet was implemeted to screen potential s/n 035 failure modes on a flight to flight basis. CAUSE(s)/PROBABLE Cause(s): The cause of the WSB leak was determined to be an intergranular crack completely around the valve inlet stem of the lube oil spray valve. Only small ligaments between the crack ends held the valve stem together. The crack resulted from intergranular corrosion completely within the E-Brite material. The corrosion initiated at the ID and progressed to the outside diameter (OD) of the tube. CORRECTIVE_ACTION: The WSB 3 valves were replaced with valves that had been screened for cracks. The spray valve inlet tubes on WSB's 1 and 2 were torqued to assure no similar cracks were present. The WSB systems on OV-105 were successfully leaked tested. The remainder of the flight and spare valve inlet stems were successfully torqued to assure no similar large cracks were present. The pending failure analysis will be documented in the CAR 68RF06- 010. RATIONALE FOR FLIGHT: Failure analysis to date indicates the s/n 035 valve failure was unique. The remaining valves were inspected for extensive cracks s found in s/n 035 and none were found. If a similar failure were to recur, the vehicle is certified to return from orbit with two of three WSB's.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-11	Hydraulics
GNC-01	**GMT:**		**SPR** 68RF07	**UA**	**Manager:**
			IPR HYD-5-08-0203	**PR** 67V-0010	
					Engineer:

Title: Slow Pressure Increase During Rudder Channel 3 Secondary Actuator Check (ORB)

Summary: INVESTIGATION/DISCUSSION: At 283:12:10 G.m.t (010:00:54 MET), the rudder channel 3 secondary differential pressure was observed to lag behind the command by approximately 1.96 seconds at the 1000 psi level during the positive stimulus portion of the secondary actuator check of the flight control system (FCS) checkout procedure. The channel did bypass normally at the required pressure. The channel also bypassed nominally during the negative stimulus portion of the test. For nominal operation of the rudder/speedbrake, 3 of 4 servo valves are required.

A delay of 1.44 seconds was noted on OV-105's previous flight (STS-59). Data review also shows that the delay occured on STS-57 (less than 1 second), STS- 54 (less than 0.25 second), and STS-49 (0.15 second). There were no delays apparent on STS-47 or STS-61. Trouble-shooting and data review at KSC also indicate slow pressure rise during rudder channel 3 secondary actuator checks. The most probable cause of the slow pressure rise is a failure in the hydraulic module channel 3 servo valve secondary spool. The failure in the secondary spool can not be determined until vendor testing and analysis is completed. The rudder speedbrake power drive unit (PDU) has been removed and replaced. The PDU has been sent to the vendor for testing, tear-down and analysis. The testing, and failure analysis will be tracked under CAR 68RF07. CAUSE(s)/PROBABLE Cause(s): A failure in the hydraulic module channel 3 servo valve secondary spool was the most probable cause of the delay. CORRECTIVE_ACTION: Rudder speedbrake PDU was removed and replaced. RATIONALE FOR FLIGHT: Rudder speedbrake PDU was removed and replaced. The loss of a servo valve will not effect nominal system operation due to the servo valve redundancy (3 of 4 required).

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-68-V-12	OI - Recorders
INCO-07	**GMT:**		**SPR** 68RF11	**UA**	**Manager:**
			IPR 67V-0014 INS-0182	**PR** INS-0182	
					Engineer:

Title: OPS Recorder 2 Track 8 Failure (ORB)

Summary: INVESTIGATION/DISCUSSION: During the STS-68 postlanding operations at Dryden Flight Research Center (DFRC), the ground equipment did not lock onto the operations (OPS) recorder 2 serial number (s/n) 1010 track 8 dump data in either the forward or the reverse directions. Repeated attempts to dump track 8 at DFRC were unsuccessful. All other tracks were successfully dumped.

The failure repeated at KSC during testing which included recording and playing back new data on track 8 in the forward and reverse directions. The recorder was removed from the vehicle and sent to the NASA Shuttle Logistics Depot (NSLD), where it will remain until a repair contract is negotiated with the vendor. STS-68 was the seventh flight of this recorder on OV-105. A review of the failure history of OPS recorder s/n 1010 indicated no previous failure of this type. However, there have been numerous similar failures on other recorders that were caused by the degradation of either the record head or reproduce head, or failure of the associated record or reproduce electronics. CAUSE(s)/PROBABLE Cause(s): The most likely cause of this failure is degradation of either the record head or the reproduce head due to wear caused by normal recorder operations. CORRECTIVE_ACTION: The recorder has been removed from the vehicle and replaced with s/n 1011. Serial number 1011 functioned nominally during checkout and testing. RATIONALE FOR FLIGHT: There are two OPS recorders onboard, each having a criticality of 3/3. Flight rules allow continuation to nominal end-of-mission in the event of loss of all recorders. This failure is not considered generic, but the failure of the heads is always a possibility in a magnetic tape recorder due to the use of electro-mechanical components and the physical wearing of the tape and heads due to normal operation.